

applications where a higher power limit is justified. Specifically, where the antenna is not in the proximity to the user, Telocator proposes that the permissible operating power be raised to 12 Watts.¹³ An example would be vehicle mobiles where the antenna is located on a metal roof that shields the passengers from RF exposure.

While a hand-held PCS device operating at 12 Watts ERP poses questions regarding RF exposure, the separation required to lower the exposure below the "uncontrolled" limits in ANSI/IEEE C95.1-1992 is measured in inches. Thus, in situations where users and the other members of the general public will be separated from the antenna by more than a few feet, the use of 12 Watts ERP mobiles does not raise an RF exposure issue.

Allowing vehicle based mobile units to use 12 Watts ERP can be an important consideration in providing service in rural areas. There are also other applications where this capability will provide important benefits to the public, like temporary facilities to provide additional capacity to supplement normal landline capabilities such as special events or disaster relief efforts (e.g. FEMA). In addition, when landline facilities are impaired, PCS facilities can provide temporary service to the general public when no alternatives are readily available. It is expected that these applications will use high gain antennas to maintain the important balance between transmit and receive paths.

As a result, Telocator proposes that the FCC establish a separate class of mobile devices utilizing external antennas which are allowed to operate at power levels up to 12 Watts ERP. Note, that this request is independent of Telocator's request for base station

¹³ At 1.8 GHz, 10 dBd antennas are compact enough to be usable in many portable applications. A 10 dBd antenna combined with a 1.2 watt radio produces 12 watt ERP.

ERPs up to 1 kW. As discussed above, there are a number of cases where a 1 kilowatt base station and 1.2 Watt mobile units will result in a balanced link.

* * * * *

In summary, retaining the existing base station ERP limit of 62 Watts would impede the ability of PCS operators to economically provide service to citizens located in small towns and rural areas and imperil the Commission's stated objective of providing PCS service to 90 percent of the population by the 10th year. It would also impose severe operating restrictions on new technologies such as TDMA and CDMA. To resolve these issues, Telocator proposes that the limit on base station ERP be raised to 1,000 W. This represents only a doubling in the allowed cellular power, far less than the impact of the frequency change alone.

II. THE COMMISSION SHOULD ADOPT EMISSION LIMITATIONS THAT REDUCE INTERFERENCE POTENTIAL BETWEEN ADJACENT CHANNEL PCS OPERATIONS.

The emission limits specified in the *Second PCS R&O* apply only to emissions outside the PCS band, i.e., no explicit protection is provided to other PCS operators using different frequency blocks in the same area. Telocator believes that intra-PCS protection should also be mandated. Therefore, Telocator proposes that the Commission revise Section 99.234(a) to apply the limitations imposed for out of band emissions to the PCS spectrum as well. In addition, Telocator proposes that existing §99.234(a) could be clarified by specifying the

resolution bandwidth over which the measurement is to be made and by formally defining the units of the term P.¹⁴ The proposed revision would read as follows:

§99.234 Emission Limits.

- (a) On any frequency outside the frequency block(s) licensed to the licensee, the power of any emission shall be attenuated below the transmitted power (P, measured in Watts) by at least $43 + 10 \log_{10} (P)$ decibels or 80 decibels, whichever is the lesser attenuation.

NOTE 1: The measurement of emission power can be expressed in peak or average values, provided they are expressed in the same parameters as the transmitter power.

NOTE 2: Compliance with the emission limits is based on the use of measurement instrumentation with a resolution bandwidth approximately equal to 1.0 percent of the emission bandwidth of the device under measurement.

- (b) [unchanged]

III. REGULATIONS FOR PCS-MICROWAVE FREQUENCY COORDINATION SHOULD PROVIDE GREATER FLEXIBILITY TO ACCOMMODATE FURTHER INDUSTRY DEVELOPMENTS.

The FCC's rules governing coordination of new PCS systems are wisely based in large part on EIA/TIA's Bulletin TSB10-E. Indeed, the FCC is to be commended for its ongoing participation in the TR14.11 meetings on this subject and its incorporation of a number of TIA agreements into the rules despite that Bulletin 10-F is still in a draft form. Utilizing the consensus positions of an accredited industry standards group to deal with the technical issues involved in PCS-microwave frequency coordination is consistent with the positions advocated by both microwave users and PCS entrants alike. However, incorporating draft revisions to TSB10-E into the regulatory framework for PCS-microwave

¹⁴ The proposed clarification on resolution bandwidth is taken from Section 15.321(d) also adopted in the *Second PCS R&O*.

interference ignores ongoing discussions still occurring in TIA and may unnecessarily constrain TIA's ability to flexibly implement additional consensus solutions to PCS-microwave engineering problems. Telocator therefore requests Commission reconsideration of a few issues in order to ensure TIA's ability to achieve the twin objectives of avoiding interference while promoting rapid deployment of PCS.

Future Revisions of TSB10. As the FCC's *Second PCS R&O* recognizes, a revised version of TSB10-E is in the process of being implemented. And, while the *Second PCS R&O* notes that the FCC "would accept the new TSB10-F, when adopted by EIA/TIA, for use demonstrating compliance with [the] technical standards,"¹⁵ the *Second PCS R&O* in many other places only makes reference to TSB10-E.¹⁶ In order to avoid having to reform the rules as TSB10 gets updated to version 10-F and beyond, the FCC should clarify that the appropriate reference is the latest revision of TSB10, regardless of the version letter.

Propagation model. Although the rules are silent on the issue of the propagation model to be used in calculating PCS-microwave interference, the *Second PCS R&O* itself states that "[p]ath loss in general . . . will be based on the Longley/Rice propagation model."¹⁷ While the Longley/Rice propagation model is appropriate in many circumstances, Telocator notes that mandating use of the Longley/Rice model is inconsistent with current TIA discussions. On balance, Telocator believes the best policy would be to default to the

¹⁵ Order at ¶ 150 n.116.

¹⁶ See, e.g., ¶¶ 143, 145, 146 & 147. See also 47 C.F.R. § 99.233(h) (Indeed, this section specifies reliance on TSB10 C/I criteria for PCS-to-microwave interference which will only be implemented in version 10-F and beyond).

¹⁷ Order, ¶ 172.

Longley/Rice model only in the event that TIA members cannot achieve consensus agreement on the use of other models in the process to revise TSB10.

For example, Telocator notes that the specific stated criticisms of the "Hata model" may no longer be applicable since the current TIA-accepted "Hata model" includes a number of modifications that overcome the identified shortcomings. Thus, even though the Hata model requires an adjustment to compensate for minor problems in differentiating between urban and suburban environments, the modified Hata model appears no less accurate than the Longley/Rice model, which requires an environment "correction factor" of 10-35 dB.¹⁸ Telocator believes that the Hata model, as modified, is also appropriate for coordinator use within the applicant's boundaries.

Propagation Calculations. As discussed above, the FCC has commendably attempted the difficult task of blending draft TIA propagation assumptions with the basic Longley/Rice propagation model in Appendix D to the Commission's Order. Again, however, codification of the draft TIA assumptions may thwart ongoing TIA processes because TIA is in the process of developing recommendations on the precise issues the FCC has decided.¹⁹ Because TIA's efforts involve a much more detailed technical assessment of potential interference, TIA's resolution of the issues may be somewhat different than mandated in the order. Telocator believes that such efforts should nonetheless be recognized and parties should be permitted to utilize the assumptions adopted by consensus in TSB10-F.

To illustrate the relative level of detail, the *Second PCS R&O* states "that until more experience is gained we should take a conservative approach and assume that all PCS

¹⁸ Footnote 125 and Appendix D.

¹⁹ See TR14.11/93.11.1-61. See also TIA TR14.11/93.11.03-56 for a comparison of Longley/Rice to T.I.A.'s modified Hata/CCIR model.

channels are active for interference purposes."²⁰ TIA's approach to this question in the TSB10-F draft is basically similar, but the TIA draft also provides additional definitional details necessary to apply the statement in cases--like CDMA systems--where the meaning of "all channels" may not be immediately evident.²¹ Similarly, TIA's TSB10-F draft recognizes that in coordination situations involving large numbers of base stations with portable units contending for channels, trunking theory dictates that less than 100 percent of the channels will be used.²² Because TIA's efforts are consistent with the FCC's basic approach, but include contextual detail that would assist in resolving similar coordination problems in a consistent manner, Telocator urges the Commission to consider modifying the coordination assumptions in the rules to place greater reliance on TSB10 and TIA consensus positions.

IV. THE COMMISSION SHOULD CLARIFY APPLICATION FILING PROCEDURES.

Telocator commends the FCC for attempting, to the degree possible, to minimize the paperwork burden imposed on both its staff and on applicants. In particular, the Commission's rules state that "[b]lanket licenses are granted for each market and frequency block," and that "[a]pplications for individual sites are not needed and will not be accepted."²³ While Telocator supports eliminating unnecessary paperwork, it believes this

²⁰ Order at ¶ 173.

²¹ CDMA systems typically have theoretically large numbers of "channels" (codes) while only using a small subset.

²² Since the quality of service (e.g. blocking and delays) decreases rapidly as channel demand increases toward 100%. T.I.A. is currently recommending 50% for this condition.

²³ 47 C.F.R. § 99.11.

rule should be reconsidered in light of proposals in the FCC's recent *Notice of Proposed Rulemaking* on competitive bidding procedures. Specifically, the *Auction NPRM* proposes to impose Sections 22.3 through 22.45 of the Public Land Mobile Service rules and Sections 22.917(f) and 22.918 through 22.945 of the Public Cellular Radio Telecommunications Service rules on PCS filings, which do collectively mandate individual site informational filings.²⁴

While the prospect of adapting the cellular rules for PCS has considerable allure in terms of simplicity, the operational requirements of PCS systems will be very different from cellular systems and failing to consider these differences may ultimately result in wasteful expenditure of resources by both applicants and the Commission. For example, Telocator believes, on balance, that some information about constructed stations must be made available to analyze and resolve interference problems that may arise between systems that are adjacent in either space or frequency. Given the large number of stations anticipated, however, applying the cellular filing rules would be extremely burdensome. In addition, as Telocator has noted in its auction comments,²⁵ requiring the submission of engineering material prior to construction would be burdensome and of limited utility. For this reason, Telocator believes the Commission should consider streamlining application processing and information retrieval by authorizing electronic filing of PCS applications.

Electronic filing of individual site information for PCS is a particularly appropriate use of information age technology to streamline government. Under such a scheme, the Commission, or a designated contractor, would receive PCS filings electronically for a small

²⁴ Auction NPRM at ¶ 128.

²⁵ Comments of Telocator at 12-14, PP Docket No. 92-253 (filed November 10, 1993).

fee, and convert the filings into an electronic database that could be accessed by the Commission and by the general public. This would considerably ease processing, facilitate accessibility of data, and significantly reduce costs. In furtherance of this proposal, Telocator has designated a task force to develop electronic filing procedures.²⁶ In effect, all the FCC would be required to do upon reconsideration would be to provide an appropriate fee structure for the filings.

Another area where the Commission's rules unintentionally result in significant burdens upon PCS operators without a concomitant benefit lies in new Section 99.53(e) which requires the location of PCS antenna sites to be determined with an accuracy of no less than ± 5 meters in both the vertical (ground elevation) and horizontal (latitude and longitude) planes. Independent of whether individual site filings are required, it is unclear why such detailed information is needed considering the expense of complying with the ± 5 meter horizontal precision requirement.²⁷ To the degree that any individual site filings are required, Telocator therefore suggests allowing horizontal coordinates to be specified, as they

²⁶ This task force will call upon the resources of Telocator's membership and work with the Commission staff to develop detailed filing procedures to be submitted within the next 45 days. The task force will also consult with TR14.11 so that the electronic filing format is appropriate for use in coordinating planned PCS sites with fixed microwave operations and resolving interference problems between constructed stations.

²⁷ Achieving ± 5 meter horizontal precision is likely to require a costly manual survey. Even if 4 SV coverage is available, which is not always the case in urban environments, differential GPS using RTCM-104-SC pseudorange correction messages is not guaranteed to meet this accuracy requirement. Accordingly, costly interferometric GPS survey methods will be needed to guarantee ± 5 meter precision and will not necessarily be correlated to a map. Indeed, GPS position is given with respect to an absolute reference ellipsoid such as WGS-84, NAD-83, or NAD-27. In contrast, maps are absolute referenced to a reference ellipsoid but typically exhibit much better relative accuracy over short distances. The accuracy with which a GPS based position can be related to a typical USGS map is rarely as good as ± 5 meters.

are now for most services, with a precision of ± 1 second on a 7.5 minute quadrangle map of the same accuracy.²⁸

V. THE COMMISSION SHOULD MODIFY ITS RULES FOR PCS SERVICE AREAS TO DESCRIBE GENERICALLY THE COUNTIES CONTAINED IN EACH SERVICE AREA.

The Commission's rules defining PCS service areas by reference to major trading areas ("MTAs") and basic trading areas ("BTAs") refer specifically to works that are commercially published by Rand-McNally & Co. Telocator suggests that Section 99.13 of the Commission's Rules be modified to specify (a) the counties contained in each BTA and (b) the BTAs contained in each MTA. This generic approach will place information more efficiently and cost-effectively in the hands of the public and will provide several benefits in administering PCS.

First, the service area descriptions would be set out in full in the Code of Federal Regulations or in separate Commission releases, making those descriptions fully accessible at little or no cost to the public and to parties planning for PCS nationwide.²⁹ This approach would increase public access to government information, a goal of the current

²⁸ Telocator also suggests that the Commission may wish to consider requiring additional transmit site and local environment detail (e.g., street location, nearby structures, building floorplans) to be appended when needed to properly coordinate the site with other systems and fixed microwave users.

²⁹ Although Rand-McNally publications are widely available, some markets have been sold out of MTA and BTA maps for months (and these maps are only published by Rand-McNally in rather large atlases costing several hundred dollars). In some markets, four- to six-week backorders for MTA and BTA atlases have become commonplace. We also understand that copies of MTA and BTA data on computer diskette are sold by Rand-McNally for \$1,000. See Killen Associates, Inc., Petition for Reconsideration (filed Nov. 30, 1993). Adoption of Telocator's proposal would result in the removal of this unforeseen roadblock to the development of PCS that has a particularly acute impact upon small, entrepreneurial PCS enterprises.

Administration, and would lower costs that otherwise could particularly disadvantage small businesses.³⁰ This process would parallel that used for cellular, which has been a success.

Second, these more precise definitions could track specifically the Commission's decision to create a separate MTA for the state of Alaska and several MTAs and BTAs for several insular areas. The approach we propose thus would more accurately reflect the Commission's decisions in both its PCS Reports.³¹

Third, this approach would protect against the possibility that the 1992 version of the Rand-McNally publication on which the Commission relies could go out of print or that Rand-McNally's MTAs or BTAs could be modified to be inconsistent with the areas on which the Commission based its PCS decisions. It also would prevent parties seeking alterations in licensing areas from embroiling Rand-McNally, a private party, in requests to alter BTAs or MTAs.

Fourth, this approach would make it easier for the Commission to adopt similar service areas for other Commission-licensed services by standardizing the information on which those service areas would be based. The Commission has proposed to utilize BTAs for the local multipoint distribution service, for example; having the counties that comprise BTAs set out specifically in the Commission's rules or in a Commission release would make it easier for the Commission to use MTAs and BTAs in the future.

³⁰ The cost of obtaining MTA and BTA data from Rand-McNally could have a ripple effect through the industry, causing costs for system planning, application preparation and other services to be increased. *See id.* (reporting that Rand-McNally generally charges \$12,000 plus 5 percent of net sales to attorneys, engineers and consultants wishing to utilize MTA and BTA data in serving clients).

³¹ The Commission separated Alaska from the Seattle MTA, and created "MTA-like areas" for Guam and the Northern Mariana Islands; Puerto Rico and the U.S. Virgin Islands; and American Samoa. The Commission also defined American Samoa, Guam, the Northern Mariana Islands, Puerto Rico, and the U.S. Virgin Islands as "BTA-like areas."

Finally, this approach would cure any copyright or trademark concerns that some parties may have. In particular, one pending petition for reconsideration points out that some small businesses may fear being held liable for copyright infringement by Rand-McNally if they use "MTAs" or "BTAs" without paying licensing fees directly to Rand-McNally.³² Although it is highly questionable that Rand-McNally would have any intellectual property rights either in the names "MTA" or "BTA" or in the facts of which counties are contained in each "BTA,"³³ describing PCS service areas by the generic counties contained in them would alleviate any doubt.

In summary, then, the public and the industry would benefit by a more specific and generic description of PCS service areas. A proposed Amended Section 93.13, including a description of the counties within each BTA and the BTAs within each MTA, is attached to this Petition.

VI. ONLY HAND-HELD SUBSCRIBER UNITS SHOULD AUTOMATICALLY BE REQUIRED TO COMPLY WITH THE RF EXPOSURE STANDARD FOR THE UNCONTROLLED ENVIRONMENT.

Telocator is also requesting clarification of the application of the uncontrolled/controlled environment distinction for new PCS systems. In particular, the

³² See Killen & Associates, Inc., Petition for Reconsideration (filed Nov. 30, 1993).

³³ One cannot claim copyright protection for facts or ideas, but only to particular expressions of facts or ideas. In the case of MTAs and BTAs, Rand-McNally legitimately may claim a copyright in the specific maps it has produced but cannot claim a copyright in the fact or idea that certain counties are grouped in certain BTAs and MTAs. See *BellSouth Advertising & Publishing Corp. v. Donnelley Information Publishing, Inc.*, 999 F.2d 1436, 1441 (11th Cir. 1993); *Kern River Gas Transmission Co. v. Coastal Corp.*, 899 F.2d 1458, 1464 (5th Cir. 1990) (finding certain maps not copyrightable); *Mathew Bender & Co. v. Kluwer Law Book Publishers*, 672 F. Supp. 107 (S.D.N.Y. 1987). It is not at all unusual for private companies to define areas that are incorporated in the Commission's Rules; as one example, Arbitron produces definitions of "areas of dominant influence" that are referenced in the Commission's Rules. See, e.g., 47 C.F.R. § 73.3555(d)(3) (1992).

Commission *Second PCS R&O* concludes that "[f]or the purpose of type acceptance of PCS equipment we will require that all *hand-held PCS devices* comply with the IEEE/ANSI criteria for 'uncontrolled' environments," based on the proximity of the transmitting element to the user's head.³⁴ However, the text of Section 99.52 states that *all* PCS equipment is deemed to operate in an "uncontrolled" environment, which would include PCS base stations and non-handheld mobile units. Because the Commission's rationale for requiring compliance with "uncontrolled" environment exposure standards applies only to handheld transceivers, Telocator believes that the rule language should be rephrased to harmonize with the conclusion in the text and to permit PCS manufacturers and system operators to utilize the controlled environment exposure standards where otherwise applicable such as isolated base station locations that are only visited by trained employees cognizant of the issues surrounding RF exposure.

VII. THE LISTEN-BEFORE-TALK TIME FOR UNLICENSED PCS DEVICES SHOULD BE INCREASED.³⁵

As a final matter, Telocator suggests modifying the 10 millisecond ("ms") period specified in the listen-before-talk ("LBT") rule, and corresponding frame time, to 20 ms to permit the widest range of present and future technologies to operate in the unlicensed PCS band in the most equitable manner. As an initial matter, the 20 ms time frame modification is a multiple of 10 milliseconds which will avoid time/spectrum collisions and permit a more

³⁴ Order at ¶ 192 (emphasis added).

³⁵ Notwithstanding significant debate, Telocator's membership was unable to reach consensus on a number of issues surrounding the deployment of unlicensed PCS devices and therefore limits its discussion to this one issue. Telocator will review the other petitions for reconsideration that it anticipates will be filed in this proceeding and reserves the right to further address issues raised relative to unlicensed PCS in comments to those petitions.

flexible set of solutions within the unlicensed band. Furthermore, a 20 ms LBT period allows a greater range of technologies to use the unlicensed band, including several high compression vocoders that specifically require a 20 ms frame time. In addition, the additional 10 ms delay is not a significant impact on communications channel setup time. The idle portable may be searching in anticipation of an appropriate place in which to transmit, in which case there is no additional delay imposed. Accordingly, Telocator believes that the public interest benefits of a longer LBT period and frame time outweigh the minor consequences of an additional 10 ms delay.³⁶

VIII. CONCLUSION

For the foregoing reasons, Telocator respectfully requests Commission reconsideration and clarification of regulations adopted in the Second Report and Order in the PCS proceeding. Specifically, the Commission should:

- Increase maximum PCS power levels from 62 Watts ERP to 1,000 Watts ERP for base stations and from 1.2 Watts ERP to 12 Watts ERP for some mobiles;
- Extend the out-of-band emissions criteria to govern interference between adjacent PCS licensees and clarify that the resolution bandwidth for measuring out-of-band emissions is 1.0 percent of the emissions bandwidth;
- Modify the PCS-microwave interference criteria to allow TIA's TR14.11 committee greater flexibility to implement industry consensus solutions to engineering problems arising from coordinating PCS systems with fixed microwave users;
- Clarify the application filing procedures regarding site-specific information and work with Telocator's Task Force to develop workable, practical, and cost-effective electronic site filing requirements;

³⁶ This proposed modification would require revision to Sections 15.321(c)(1), (c)(5), and (c)(6) as well as 15.321(e).

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³⁶ This proposed modification would require revision to Sections 15.321(c)(1), (c)(5), and (c)(6) as well as 15.321(e).

"Standard" DCS-1900 Link Budget

Exhibit A

Uplink			Downlink		
Mobile TPO	33	dBm	Base Station TPO	42	dBm
Cable Losses	-2	dB	Cable Losses	-2	dB
Mobile Antenna Gain	0	dBd	Base Station Antenna Gain	15	dBd
Effective Radiated Power	31	dBm	Effective Isotropically Radiated Power	55	dBm
1.2 watts ERP			316 watts ERP		
Path Losses	-152	dB	Path Losses	-152	dB
System Margin	-1	dB	System Margin	-1	dB
Base Station Antenna Gain	15	dBd	Mobile Antenna Gain	0	dBd
Diversity Gain	5	dB	Cable Losses	-2	dB
Cable Losses	-2	dB	Mobile Rx	-100	dBm
Base Station Rx	-104	dBm			
Base Station Antenna Height	120	feet	Base Station Antenna Height	120	feet
Mobile Antenna Height	5	feet	Mobile Antenna Height	5	feet
Coverage Radius (COST231 Urban)	1.75	miles	Coverage Radius (COST231 Urban)	1.75	miles
Coverage Radius (COST231 Suburban)	4	miles	Coverage Radius (COST231 Suburban)	4	miles
Coverage Radius (COST231 Rural)	13	miles	Coverage Radius (COST231 Rural)	13	miles

NOTE: "Optimistic" coverage radii without penetration/obstruction losses.

DCS-1900 Link Budget with Smart Antenna

Exhibit B

Uplink			Downlink		
Mobile TPO	33	dBm	Base Station TPO	42	dBm
Cable Losses	-2	dB	Cable Losses	-2	dB
Mobile Antenna Gain	0	dBd	Base Station Antenna Gain	20	dBd
Effective Radiated Power	31	dBm	Effective Radiated Power	60	dBm
1.2 watts ERP			1000 watts ERP		
Path Losses	-157	dB	Path Losses	-157	dB
System Margin	-1	dB	System Margin	-1	dB
Base Station Antenna Gain	20	dBd	Mobile Antenna Gain	0	dBd
Diversity Gain	5	dB	Cable Losses	-2	dB
Cable Losses	-2	dB	Mobile Rx	-100	dBm
Base Station Rx	-104	dBm			
Base Station Antenna Height	120	feet	Base Station Antenna Height	120	feet
Mobile Antenna Height	5	feet	Mobile Antenna Height	5	feet
Coverage Radius (COST231 Rural)	18	miles	Coverage Radius (COST231 Rural)	18	miles

NOTE: "Optimistic" coverage radii without penetration/obstruction losses.





EXHIBIT B

1994 PCS Market Demand Forecast

**Personal Communications
Industry Association**

January 1994

Introduction

The introduction of cellular service in late 1983 was a cannon shot in the second revolution in communications - mobility. By 1992, over 15 million Americans used pagers and over 11 million used cellular telephones. In the fall of 1993, another shot could be heard as the FCC announced the structure of the new Personal Communications Services (PCS) industry.

New PCS will combine with existing services such as cellular and paging to fundamentally change the way millions of Americans communicate. By 2003, we predict over 52 million subscriptions for cellular telephones, 65 million subscriptions for paging and messaging services, and 31 million subscriptions for New PCS. Additional tools such as mobile satellite terminals, special mobile data services, and advanced dispatch services will also help our diverse economy communicate without the constraints of wires. In sum, this study forecasts 167 million subscriptions to PCS services by 2003.

The Personal Communications Industry Association (formerly Telocator), conducted this study to evaluate the growth, composition, and characteristics of the future personal communications industry through a survey of mobile communication's industry leaders. The results of the survey indicate the pace and extent of the second communications revolution as America moves into the next century.

History of this Study and Forecasting Methodology

In 1992, PCIA completed its first PCS Market Demand Forecast. Since its release, the report has been cited in Congressional hearings, quoted in trade media, examined by Wall Street analysts, and referred to by companies in the telecommunications industry to support market analyses. This year, PCIA updated the findings to reflect new data from over 100 PCS marketing and technical trials conducted in the United States during the last year and a half.

PCIA, which consists of over 450 companies engaged in developing services and products for the personal communications industry, defines personal communications service (PCS) as *"a broad range of individualized telecommunications services that enable people or devices*

to communicate independent of location." The PCS family of services includes New PCS 1800-2200 MHz. cellular, paging, SMR\ESMR, and dedicated data services. It is PCIA's view that PCS services will revolutionize the way people communicate. and bring wireless communications to a mass market through lower priced equipment and service charges.

PCIA solicited information from a qualified "key list" of PCIA member companies from our membership. Respondents include representatives from cellular carriers, paging carriers, network and CPE manufacturers, interexchange carriers, LECs, independent marketing research firms, government research agency data and PCS entrepreneurs. For the purpose of the survey, PCS demand was broken down into eight primary services: New PCS, cellular, paging, SMR/ESMR, dedicated data, satellite, wireless PBX, and cordless phone. Since Wireless PBX and cordless phone are not considered carrier services, this study focuses on the six primary carrier services.

A "key list" of industry experts provided data for each of the eight services regarding total anticipated service penetration, business penetration, equipment and service pricing for Year 1998 and Year 2003 (five and ten year forecasts). Respondents were also asked to indicate if information came from primary, secondary or company estimates. This year PCIA's responses included more primary and secondary estimates, reflecting better data available from market trials.

The methodology PCIA used tracks subscriptions to mobile services, not individual subscribers. The distinction is particularly important when reviewing aggregate subscriptions across services. Total subscriptions will always be greater than total subscribers because many individuals will subscribe to multiple services. Today, for example, there is a growing base of customers that utilize both paging and cellular. As the findings below point out, it is conceivable that PCS will open up new opportunities for customers to use new service offerings with multiple services. Statistical information was calculated using the consensus building Delphi method (removal of the high and low response, and averaging the remaining sample.)

The following primary findings have been prepared as an information resource for PCIA members, the financial community, federal regulatory agencies. and the public.

Primary Findings

The attached "PCS Technologies Forecast" summarizes aggregate statistical findings for the six carrier based services. The primary findings were developed from these findings. The next section lists assumptions PCIA took into account in developing the analyses below.

The primary findings include the following:

- o **All eight PCS Services studied will continue to grow, despite increased competition.** (See attached "PCS Technologies Forecast" page.) Available market research indicates that there is a very high amount of unmet demand for personal communications. Decreasing prices, advanced technologies, and creation of licenses will enable service providers to fill the demand gap.
- o **Multiservice use is expected.** The complementary nature of PCS services will create a market in which users of one wireless service may adopt additional services to enhance overall functionality. For example, cellular users may adopt an alphanumeric pager for message screening and response queuing, or companies with many mobile workers already using PCS may install a wireless PBX. Since PCIA's results show that a person is likely to use multiple services, and the demand for more than one service per subscriber may be high, the forecasts refer to quantity of subscriptions, instead of subscribers.
- o **The respondents see the New PCS as adding new value to the industry.** New PCS is not expected to replace any existing wireless technology studied, although increased competition will certainly affect the growth rate of the other services. Rather, respondents see the new services as adding new value to the industry by complementing existing services, and increasing demand for all wireless services.
- o **A wide array of services is developing, each with its own specific functionalities, service mix and market advantages.** These services each have varying price points and levels of technical complexity.
- o **Residential service growth:** New PCS will be heavily oriented to consumer service. Results show that business penetration for New PCS in Year 5 is a modest 30%, suggesting that New PCS will not necessarily

follow the traditional pattern of business to consumer migration; rather PCS may begin with the non-business or residential customer. Our results also showed paging, and to a lesser extent cellular, further expanding into the residential marketplace.

o **Data PCS:** As with the landline communications, data will comprise an increasing share of total wireless communications in the future. This was reflected by data services growth in cellular data (anticipated 2.69% penetration in 2003). Voice-plus-incremental-data is a strong component of New PCS demand, and participants projected over 70% of New PCS usage will include some type of data service.

o **Deployment:** Demand is dependent upon the timing of service deployment. The data illustrates that ESMR will grow earliest followed by CDPD, and finally New PCS voice and data service.

Service Specific Findings

NEW PCS: Although New PCS will clearly start service later than other existing wireless services, dynamic growth is expected to continue for the next decade. With service deployment anticipated for approximately 1995, total penetration is expected to grow to 3.1% by 1998 (8.5 million subscriptions) and reach 10.4% penetration in 2003 (31.1 million subscriptions.) The Year 5 to Year 10 growth rate is projected at 264%, the highest maintained growth rate of the services studied.

PAGING: With a lower price point, demand for paging and messaging services will remain strong. Today's over 19 million subscribers are predicted to grow to 36.8 million by 1998, with a predicted total penetration of about 13%. (This indicates a 1993-1998 increase of 93.7%) Results suggest Year Ten penetration will reach close to 22%, indicating that over 46 million new paging/messaging subscriptions will be registered by 2003, many of which will be consumer or non-business. Paging maintains the largest market share, anticipating 65 million subscriptions in 2003.

CELLULAR: Demand for cellular services will increase dramatically from 13 million subscriptions in 1993 to 33 million in 1998, a 154% increase. Cellular penetration is expected to grow from a reported 5% penetration at year end 1993 to approximately 12% penetration in 1998 and 17.4% penetration in 2003. Cellular is predicted to have the second largest number of subscriptions in 2003: 52 million.

ESMR/SMR: Our respondents predict that ESMR/SMR use will be over 90% business based. Anticipated penetration in Year 5 is 1.9% (5.1 million subscriptions) representing a five year growth rate of about 246%. Year Ten results predict penetration of about 3% (8.9 million subscriptions). Customer premise equipment (CPE) prices are expected to be relatively high, (\$467 average in 1998, dropping to \$275 in 2003). This price level is second only to satellite CPE.

DEDICATED DATA: Anticipated to be positioned primarily for business users, our results show growth from 50,000 subscriptions in 1993, to 3.36 million in 1998, representing an increase of over 6600%. The results forecast about 5.6 million subscriptions by 2003. The

networks will provide added value through increased flexibility and mobility for those businesses that require such services.

SATELLITE: The highest priced of the PCS services examined, CPE price will be \$1200 in 1998. Satellite service will be over 98% business, and will serve about 1.3 million subscriptions by 1998, and over 4 million subscriptions by 2003. Although satellite networks may have the fewest subscriptions of those we examined, the Year Ten growth registers at 211%.

WIRELESS PBX: Wireless PBX data in our survey had a relatively wide variance of responses on CPE price, monthly service charge, and penetration. This may suggest some confusion within the industry about this products' relative positioning. Based on data received this report does not make any conclusions about WPBX services.

CORDLESS: Nominal growth in the cordless market is anticipated, the product will remain a primarily residential product.

PCS Technologies Forecast

1993 - 2003

	1993		1998			2003		
Service	Subs. (millions)	Penetration (% of pop)	Subs. (millions)	Penetration (% of pop)	5 Yr. Subs. % Increase	Subs. (millions)	Penetration (% of pop)	5 Yr. Subs. % Increase
New PCS			8.55	3.1%		31.11	10.4%	263.9%
Satellite	0.1	.04%	1.32	0.5%	1224.0%	4.11	1.4%	210.8%
Paging	19	7.4%	36.8	13.3%	93.7%	65.3	21.7%	77.4%
Dedicated Data	0.5	.02%	3.36	1.2%	6630.2%	5.65	1.9%	67.8%
Cellular	13	5.0%	33.07	12.0%	154.4%	52.3	17.4%	58.1%
SMR/ESMR	1.5	.6%	5.19	1.9%	245.7%	8.95	3.0%	72.6%
Total PCS Services	33.7		88.3		162.4%	167.4		

The following US population figures were used: 1992/255 million; 1993/258.5; 1998/275.8 million; 2003/300.3 million.

Note: Total subscriptions includes individuals with multiple subscriptions across services (i.e. there are more subscriptions than subscribers)